# Who is Participating in Residential Energy Efficiency Programs?

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December 9, 2021

*This work was funded by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy's Strategic Analysis, under Contract No. DE-AC02-05CH11231.*

# Webinar housekeeping items

- We're recording the webinar and will post it along with the slides on our website, https://emp.lbl.gov/publications/who-participating-residential-energy
- Because of the large number of participants, everyone is in listen mode only
- Please use the Q&A box to send us your questions and comments any time during the webinar
- Moderated Q&A will follow our presentation

# Research question and motivation

**Research question**:

What are the characteristics of customers who are accessing residential energy efficiency programs?

**Motivation**:

- Energy efficiency programs benefit all customers, with additional direct benefits for the participants
- Understanding what factors are associated with program participation can help assess the extent of current inequities and identify the characteristics program administrators need to target to achieve equitable outcomes

# Characteristics studied

- Income
- Energy poverty
- Race and ethnicity
- Education
- Limited English
- Homeownership
- Building type
- Urbanization
- Age*
- Tenure*
- Vintage*

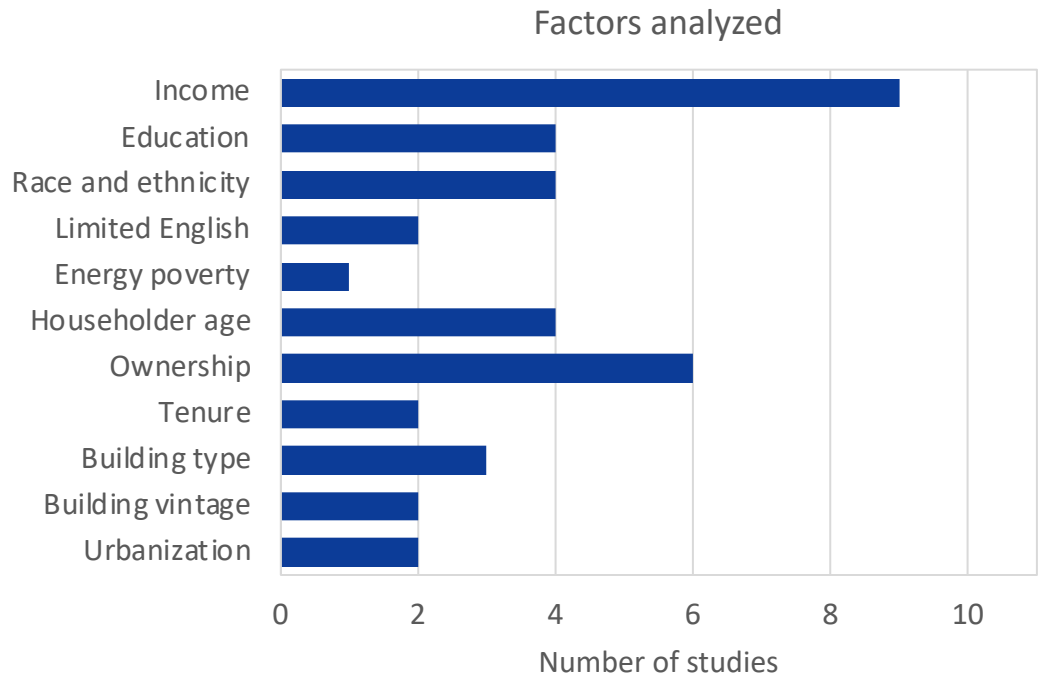
* Discussed in the report but not this presentation in interest of time.

# Methodology

- Literature review of studies relating program participation to the characteristics on the prior slide
- Analysis of data from four sources
  - 2015 Residential Energy Consumption Survey (RECS)
  - Mass Save (Massachusetts)
  - National Grid Rhode Island
  - Utility A – Midwestern state
- Statistical models
  - Single variable – Describes the association between each characteristic and participation
  - Multivariable – Many of the factors are themselves correlated. Which one is driving the pattern of program participation?

# Literature review

- Reviewed 11 studies
  - Three national; eight covering specific utilities or states
  - Eight based on surveys with household-level demographics; three using utility data and place-based demographics
  - They cover programs 2009-2019
- Factors analyzed
  - Almost all studies included income
  - At least one study looked at each of our 11 factors
- Mostly single variable analysis – describing the associations observed
- We will discuss the results from the literature review in conjunction with our analysis



# Our analysis

- We study four datasets
  - 2015 Residential Energy Consumption Survey (RECS)
  - Mass Save (Massachusetts)
  - National Grid Rhode Island
  - Utility A – Midwestern state
- They vary across many dimensions, including
  - Location
  - Years covered
  - Aggregation level
  - Sample size
  - Source of demographic data
  - Participation metric
  - Program breakdown
- We will first describe each dataset and the results for income in each dataset to illustrate the structure of our analysis
- We will then review the results from the other characteristics

# 2015 Residential Energy Consumption Survey (RECS)

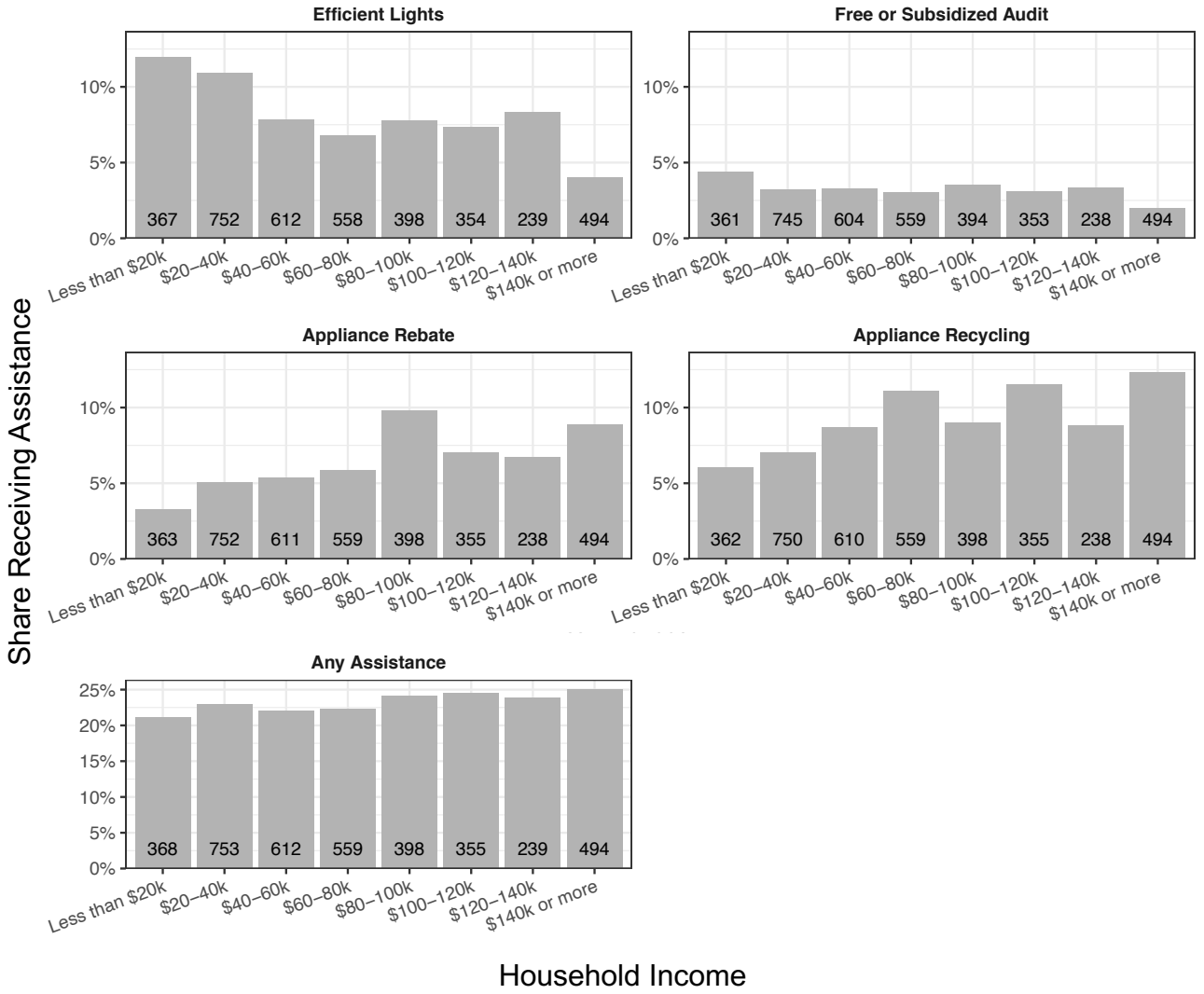
Nationally representative survey conducted periodically by the U.S. Energy Information Agency (EIA)

| | |
|---|---|
| Location | National |
| Years covered | Data collected 2015-2016 |
| Aggregation level | Household |
| Source of demographic data | Survey |
| Number of data points | 3,928 owner-occupied units |
| Participation metric | “Has your household received any of the following energy-related benefits or assistance for this home?” (yes/no) |
| Program breakdown | 4 types of energy-related assistance |

US Energy Information Agency. 2015 Residential Energy Consumption Survey.

# RECS – Income results

- Receipt of free or subsidized energy-efficient light bulbs declined as income rose; this assistance appears to be targeted at low-income households, at least in most cases
- Free or subsidized home energy audit had less variation in rates of receiving assistance among the income bins, although there was still a significant negative correlation
- Appliance rebate and recycling programs had more uptake among higher-income households



# Mass Save

Consortium of six investor-owned utilities in Massachusetts that report combined program data

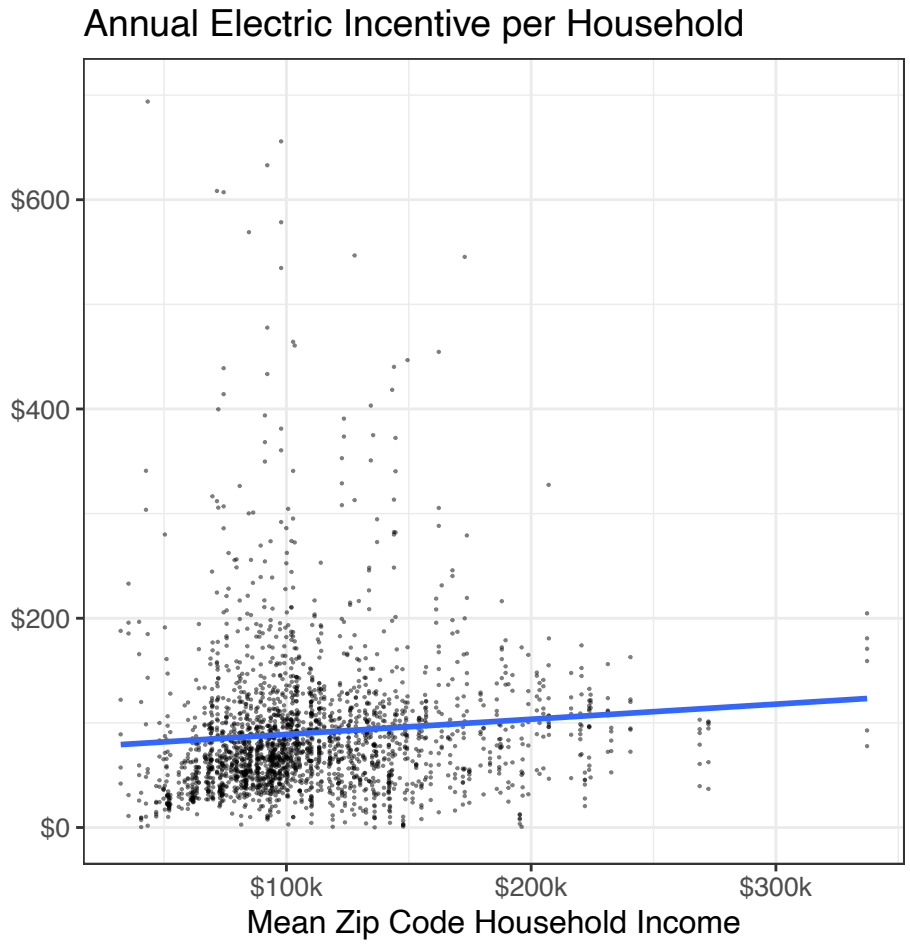
| | |
|---|---|
| Location | Massachusetts |
| Years covered | 2013-2018 |
| Aggregation level | Zip code |
| Source of demographic data | Census |
| Sample size | 472 zip codes over 6 years |
| Participation metric | Participant incentives per household ($/household) |
| Program breakdown | None (market rate and income-qualified programs are combined) |

We limit our analysis to electric incentives because of the varied geographic availability of gas service

https://www.masssavedata.com/public/home

# Mass Save – Income results

- Mean zip code income and annual household incentives had a significant positive correlation



# Utility A

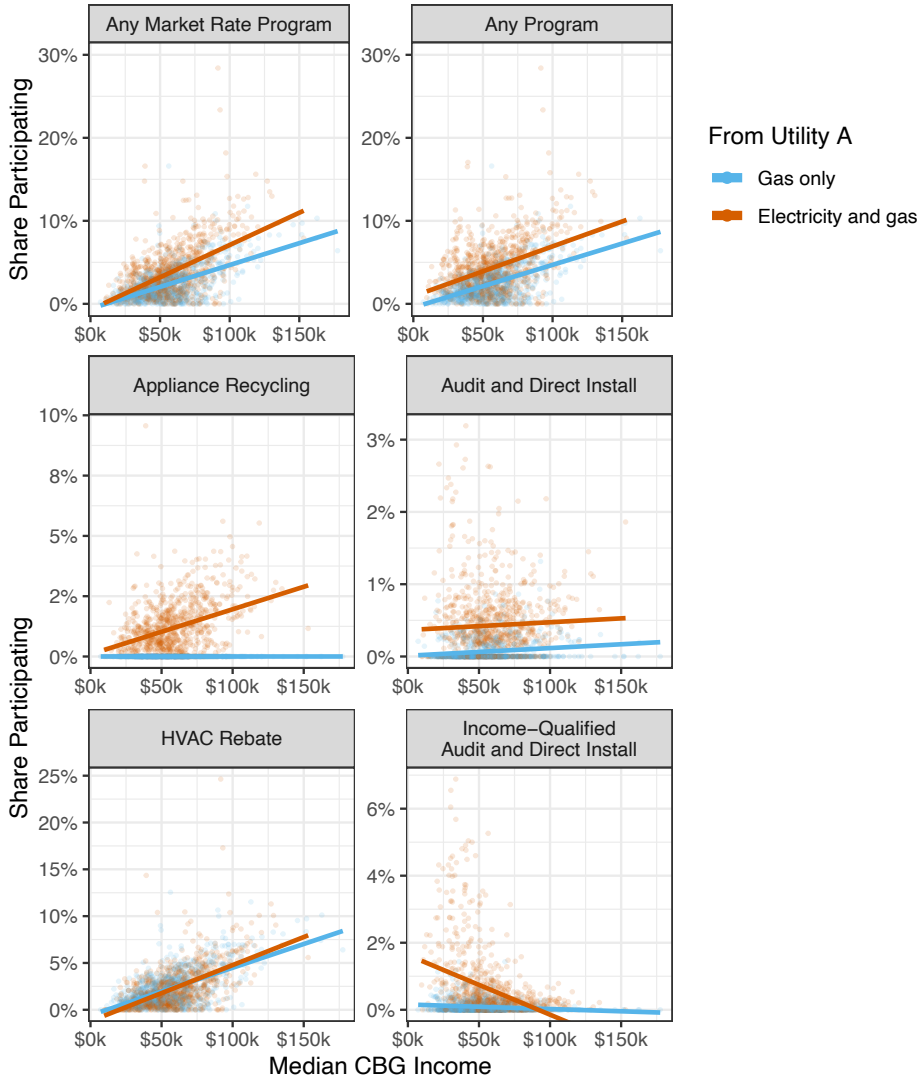
Dual fuel utility in the Midwest; some customers receive electricity from another provider

| | |
|---|---|
| Location | Midwestern state |
| Years covered | 2017–2019 |
| Aggregation level | Census Block Group (CBG)* |
| Source of demographic data | Census |
| Sample size | 1,750 CBGs |
| Participation metric | Count of participating addresses by CBG |
| Program breakdown | 4 programs (3 market rate, 1 income-qualified) |

* Geographic area designated by the Census Bureau with 600-3,000 people

# Utility A – Income results

- For all of the market-rate programs, participation rate was positively correlated with median CBG income. The relationship was weaker for the audit and direct install program.
- Participation rate in the income-qualified program was negatively correlated with median CBG income



# National Grid Rhode Island

| | |
|---|---|
| Location | Rhode Island |
| Years covered | 2015-2017 |
| Aggregation level | Zip code |
| Source of demographic data | Census |
| Sample size | 76 zip codes |
| Participation metric | Overall and eligible participation rates |
| Program breakdown | 2 programs (1 market rate, 1 income-qualified) |

We use the data from a report by Navigant, which included an estimate of the number of eligible households

Navigant Consulting (2017). Energy Efficiency Program Customer Participation Study. Prepared for: National Grid Rhode Island.

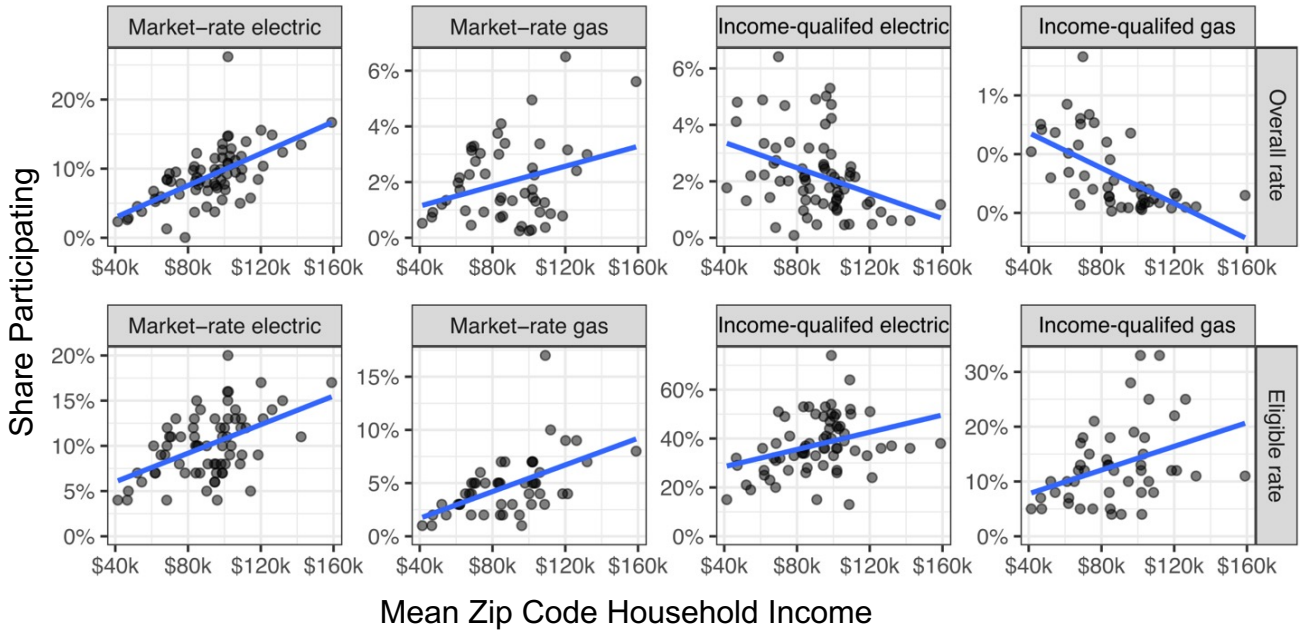
# National Grid Rhode Island – Income results

- Two participation rates

$$Overall\ rate = \frac{Participants}{Total\ households}$$

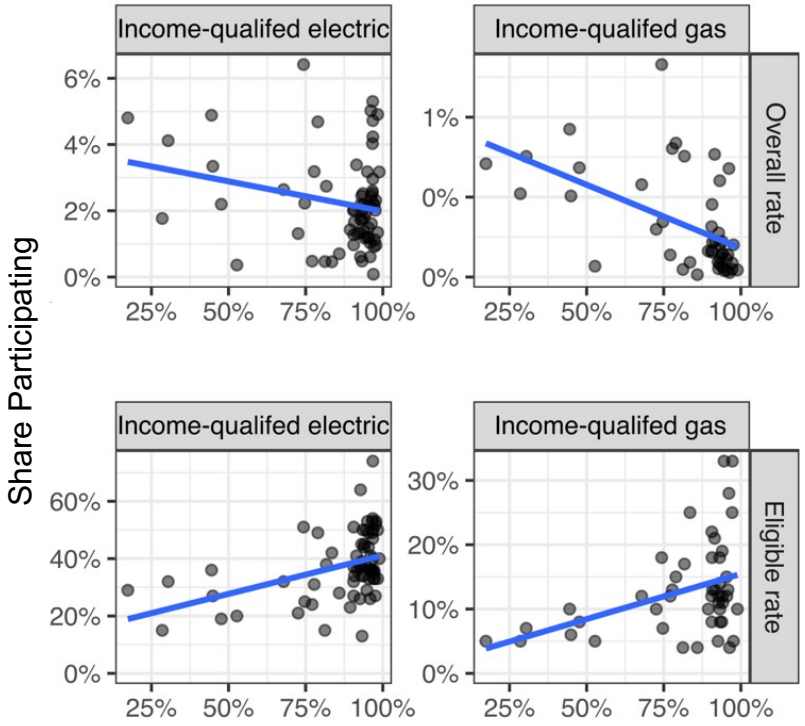
$$Eligible\ rate = \frac{Participants}{Eligible\ households}$$

- The results using the overall participation rate were the same as those for Utility A – positive correlation between participation and mean household income for the market-rate program and negative correlation for the income-qualified program
- Using the eligible participation rate, the correlation between mean household income and participation in the income-qualified program reversed

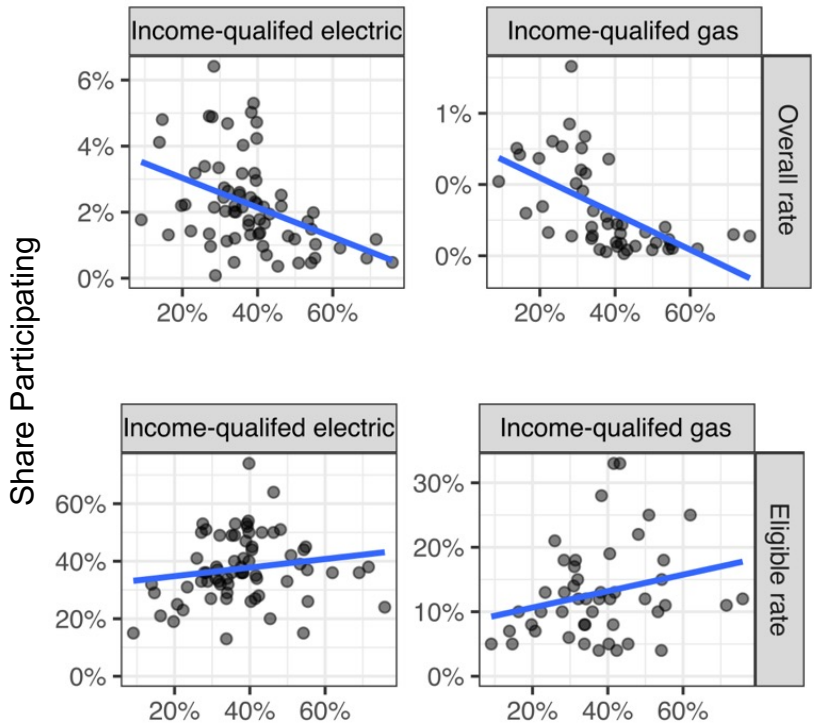


# National Grid Rhode Island – Overall vs. eligible participation

The reversal of the direction of the relationship between income and overall vs. eligible participation rate held for other characteristics




Share of Non-Latino White Householders




Share of Householders with a Bachelor's Degree or Higher

# Summarizing and comparing results

| | Household income | |
|---|---|---|
| RECS | | |
| Appliance rebate | ▲ | — |
| Appliance recycling | ▲ | — |
| Utility A (Midwest) | | |
| Income qualified audit & direct install | ▼ | ▼ |
| Audit & direct install | ▲ | — |
| Literature | | |
| | ▲ 7<br>— 3 | ▲ 2 |
| | Single variable | Multivariable |

Receipt of appliance rebates was **higher** for households with higher income in the single variable model

Participation was **lower** in CBGs with higher median incomes in the multivariable models

3 studies found **no association** between income and participation

# Characteristics studied

- Income
- Energy poverty
- Race and ethnicity
- Education
- Limited English
- Homeownership
- Building type
- Urbanization
- Age*
- Tenure*
- Vintage*
- Location

* Discussed in the report but not this presentation in interest of time.

# Income

- Except in programs targeted at low-income households, income and participation were positively correlated
  - Sometimes lost significance in multivariate models
  - Rhode Island eligible participation rate was also positively correlated with income even for income-qualified programs – among eligible households, those in zip codes with higher mean incomes were more likely to participate

| | Household income | |
|---|---|---|
| Residential Energy Consumption Survey (RECS) | | |
| Any assistance | — | — |
| Lights | ▼ | ▼ |
| Audit | ▼ | — |
| Appliance rebate | ▲ | — |
| Appliance recycling | ▲ | — |
| Mass Save | | |
| Electric | ▲ | — |
| National Grid Rhode Island | | |
| Market rate | ▲ | |
| Income qualified — eligible | ▲ | |
| Income qualified — overall | ▼ | |
| Utility A (Midwest) | | |
| Any program | ▲ | ▲ |
| Any market-rate program | ▲ | ▲ |
| Income qualified audit & direct install | ▼ | ▼ |
| Audit & direct install | ▲ | — |
| HVAC rebate | ▲ | ▲ |
| Appliance recycling | ▲ | — |
| Literature | | |
| | ▲ 7<br>— 3 | ▲ 2 |

# Energy poverty

- Definitions
  - The RECS includes three questions related to energy poverty. For example, “In the last year, how many months did your household reduce or forego expenses for basic household necessities, such as medicine or food, in order to pay an energy bill?”
  - Otherwise, we consider energy burden (percent of income spent on energy) drawn from DOE’s LEAD Tool*
- Even once income was taken into account, households with higher energy poverty generally participated less
  - Massachusetts was an exception – both our analysis and a pre-existing study show the opposite result

| | Energy poverty | |
|---|---|---|
| Residential Energy Consumption Survey (RECS) | | |
| Any assistance | — | — |
| Lights | ▲ — | — |
| Audit | — | ▼ |
| Appliance rebate | — | — |
| Appliance recycling | ▼ — | — |
| Mass Save | | |
| Electric | ▲ | ▲ |
| National Grid Rhode Island | | |
| Market rate | ▼ | |
| Income qualified — eligible | ▼ | |
| Income qualified — overall | ▲ | |
| Utility A (Midwest) | | |
| Any program | ▼ | ▼ |
| Any market-rate program | ▼ | ▼ |
| Income qualified audit & direct install | ▲ | — |
| Audit & direct install | ▼ | ▼ |
| HVAC rebate | ▼ | ▼ |
| Appliance recycling | ▼ | ▼ |
| Literature | | |
| | | ▲ 1 |

* Low-Income Energy Affordability Data (LEAD) Tool https://www.energy.gov/eere/slsc/maps/lead-tool

# Race and ethnicity

- Except for Utility A, non-Latino White householders were generally associated with participation rates at least as high as other groups
  - The exception is for efficient lighting assistance in the RECS, which is likely from income-qualified programs
- Utility A results were more similar to the literature – a mixture of positive and negative correlations
- Our detailed datasets were not from places with high racial and ethnic diversity
  - Results might be different in more diverse places
  - The lack of variation makes it harder to achieve statistical significance

| | Black householder | | Latino White householder | | Other race / ethnicity | | HoH except non-Latino White |
|---|---|---|---|---|---|---|---|
| Residential Energy Consumption Survey (RECS) | | | | | | | |
| Any assistance | — | — | ▼ | — | ▼ — | ▼ — | |
| Lights | ▲ | — | — | — | — | ▼ — | |
| Audit | — | — | — | — | — | ▼ — | |
| Appliance rebate | — | — | ▼ | ▼ | — | — | |
| Appliance recycling | ▼ | — | ▼ | — | — | — | |
| Mass Save | | | | | | | |
| Electric | ▼ | — | — | ▼ | ▼ | ▼ — | |
| National Grid Rhode Island | | | | | | | |
| Market rate | | | | | | | ▼ |
| Income qualified — eligible | | | | | | | ▼ |
| Income qualified — overall | | | | | | | ▲ |
| Utility A (Midwest) | | | | | | | |
| Any program | — | ▲ | — | ▲ | ▲ ▼ | — | |
| Any market-rate program | ▼ | ▼ | — | ▲ | ▲ ▼ | — | |
| Income qualified audit & direct install | ▲ | ▲ | ▼ | — | ▲ ▼ | ▲ | |
| Audit & direct install | ▲ | ▲ | — | — | ▼ — | — | |
| HVAC rebate | ▼ | ▼ | — | — | ▲ ▼ | — | |
| Appliance recycling | ▼ | ▼ | ▲ | ▲ | ▲ ▼ | ▲ | |
| Literature | | | | | | | |
| | — 2<br>▼ 1 | ▲ 1 | ▲ 1<br>— 2<br>▼ 1 | ▲ 1 | ▲ 2<br>— 2<br>▼ 2 | ▲ 1 | |

# Education

- Education was positively correlated with participation very consistently
- It may be a valuable factor to consider for designing program outreach

| | Householder education | |
|---|---|---|
| Residential Energy Consumption Survey (RECS) | | |
| Any assistance | ▲ | ▲ |
| Lights | — | — |
| Audit | ▲ | ▲ |
| Appliance rebate | — | — |
| Appliance recycling | — | — |
| Mass Save | | |
| Electric | ▲ | ▲ |
| National Grid Rhode Island | | |
| Market rate | ▲ | |
| Income qualified — eligible | — | |
| Income qualified — overall | ▼ | |
| Utility A (Midwest) | | |
| Any program | ▲ | ▲ |
| Any market-rate program | ▲ | ▲ |
| Income qualified audit & direct install | ▲ | ▲ |
| Audit & direct install | ▲ | ▲ |
| HVAC rebate | ▲ | ▲ |
| Appliance recycling | ▲ | ▲ |
| Literature | | |
| | ▲ 3 | ▲ 1 |

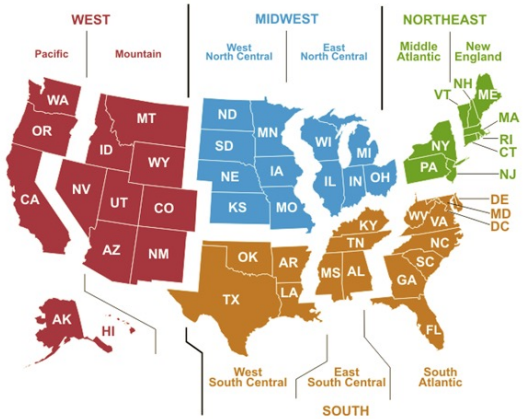
# Other characteristics of interest

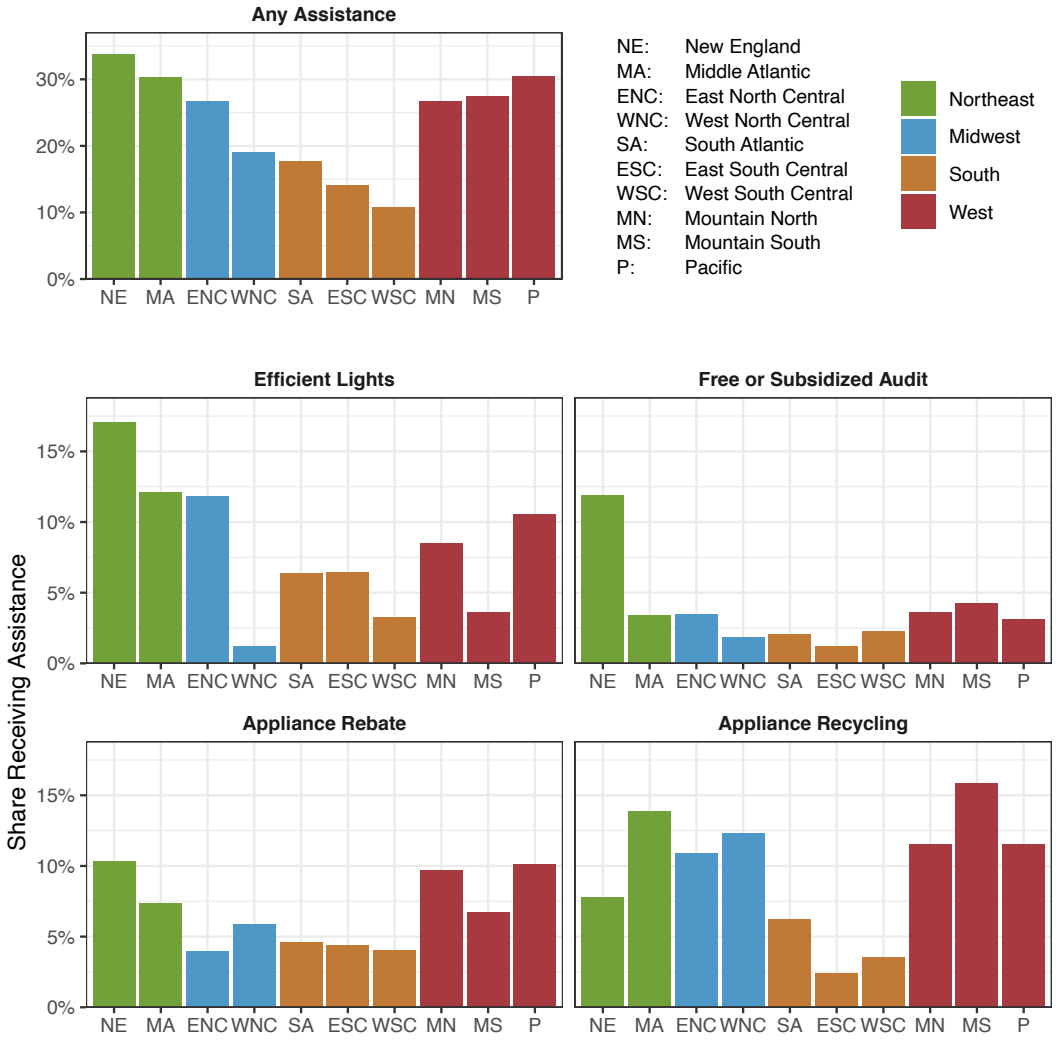
- Where it was significant, areas with more households without an adult who spoke English had lower participation rates
- Homeownership was not significant for Mass Save or any individual program in Utility A
- Participation was higher in areas with more single family homes in almost every case
  - Some programs are only available to households in single family homes
- The association between participation and urban or rural location varied substantially between datasets

| | Limited English | | Ownership | | Number of units | | Urbanization | |
|---|---|---|---|---|---|---|---|---|
| Residential Energy Consumption Survey (RECS) | | | | | | | | |
| Any assistance | | | | | ▼ | ▼ | – | – |
| Lights | | | | | ▼ | – | – | – |
| Audit | | | | | ▼ | ▼ | – | – |
| Appliance rebate | | | | | – | ▼ | ▼ – | – |
| Appliance recycling | | | | | ▼ | – | – | ▲ ▼ |
| Mass Save | | | | | | | | |
| Electric | ▼ | – | – | – | ▼ | ▼ | ▼ | ▲ |
| National Grid Rhode Island | | | | | | | | |
| Market rate | ▼ | | ▲ | | ▼ | | – | |
| Income qualified — eligible | ▼ | | ▲ | | ▼ | | ▼ | |
| Income qualified — overall | – | | ▼ | | – | | ▼ | |
| Utility A (Midwest) | | | | | | | | |
| Any program | ▼ | – | – | – | ▼ | ▼ | ▲ | ▲ |
| Any market-rate program | ▼ | – | ▲ | ▲ | ▼ | ▼ | ▲ | ▲ |
| Income qualified audit & direct install | – | ▼ | – | – | ▼ | ▼ | ▲ | ▲ |
| Audit & direct install | – | – | – | – | ▼ | ▼ | ▲ | ▲ |
| HVAC rebate | ▼ | – | – | – | ▼ | ▼ | ▲ | ▲ |
| Appliance recycling | – | – | – | – | ▼ | – | ▲ | ▲ |
| Literature | | | | | | | | |
| | ▲ 1 | ▲ 1 | ▲ 4 | ▲ 2 | ▼ 1 | ▲ 1<br>▼ 2 | ▲ 1 | ▲ 1 |

# Location – RECS

- Census division was highly statistically significant in all RECS models
- Access to energy assistance varied greatly throughout the country
  - In general, availability was highest in the Northeast and West, and lowest in the South



# Conclusions

- Education stands out as a consistent predictor of participation, even in multivariable models. Working on reaching households without a college degree could be a useful lever for engaging other underrepresented groups.
- Programs were not generally targeting households with high energy burdens, or were not targeting them effectively
- Regional differences in availability affect the potential for equity on a national scale
- Program design decisions that affect eligibility (e.g. income qualification, focused on or restricted to single family) can complicate analyses that use place-based demographics. In particular, taking eligibility into account can and does change the relationships observed.
- There seems to be opportunity to improve equity of program participation. In general, higher-income, more educated single-family homeowners participated at the highest rates in market-rate programs.

# Future work

- Gathering evidence from additional settings
- More closely assessing and incorporating program eligibility when studying determinants of participation
- Designing and applying place-based metrics to assess equity in participation (or other outcomes)
- Analyzing the effects of different program design and delivery mechanisms to determine their impacts on equity of participation, or their success in engaging generally underserved populations
- Implementing and analyzing pilot program approaches specifically targeted to achieve desired participation outcomes
- Studying the distribution of *benefits* (as opposed to *participation*)

# Questions

# ELECTRICITY MARKETS & POLICY

## Contacts

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## For more information

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## Acknowledgements

This work was funded by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy's Strategic Analysis, under Contract No. DE-AC02-05CH11231. We would like to especially thank Ookie Ma for his support of this work. For comments and input on this analysis, we also thank Jenifer Bosco, Adria Brooks, Kim Burke, Ariel Drehobl, Sydney Forrester, Natalie Mims Frick, and Miguel Heleno.

## Disclaimer



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# Appendix

# Summary

| | Household income | | Householder education | | Black householder | | Latino White householder | | Other race / ethnicity | | | Limited English | | Energy poverty | | Householder age | | Ownership | | Tenure | | Number of units | | Vintage | | Urbanization | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Residential Energy Consumption Survey (RECS) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Any assistance | — | — | ▲ | ▲ | — | — | ▼ | — | ▼ | — | ▼ — | | | — | — | ▲ | — | | | ▼ | — | ▼ | ▼ | ▼ | ▼ | — | — |
| Lights | ▼ | ▼ | — | — | ▲ | — | — | — | — | ▼ | — | | | ▲ | — — | — | — | | | — | — | ▼ | — | ▼ | ▼ | — | — |
| Audit | ▼ | — | ▲ | ▲ | — | — | — | — | — | ▼ | — | | | — | ▼ | — | — | | | — | — | ▼ | ▼ | — | — | — | — |
| Appliance rebate | ▲ | — | — | — | — | — | ▼ | ▼ | — | — | | | | — | — | — | — | | | — | — | — | ▼ | — | — | ▼ | — — |
| Appliance recycling | ▲ | — | — | — | ▼ | — | ▼ | — | — | — | | | | ▼ | — — | ▲ | — | | | ▼ | ▼ | ▼ | — | ▼ | ▼ | — | ▲ ▼ |
| Mass Save | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Electric | ▲ | — | ▲ | ▲ | ▼ | — | — | ▼ | ▼ | ▼ | — | ▼ | — | ▲ | ▲ | ▲ | — | — | — | ▲ | — | ▼ | ▼ | ▲ ▼ | — | ▼ | ▲ |
| National Grid Rhode Island | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Market rate | ▲ | | ▲ | | * | | * | | * | | | ▼ | | ▼ | | — | | ▲ | | — | | ▼ | | — | | — | |
| Income qualified — eligible | ▲ | | — | | * | | * | | * | | | ▼ | | ▼ | | — | | ▲ | | — | | ▼ | | — | | ▼ | |
| Income qualified — overall | ▼ | | ▼ | | * | | * | | * | | | — | | ▲ | | — | | ▼ | | — | | — | | — | | ▼ | |
| Utility A (Midwest) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Any program | ▲ | ▲ | ▲ | ▲ | — | ▲ | — | ▲ | ▲ | ▼ | — | ▼ | — | ▼ | ▼ | ▲ | ▲ | — | — | ▲ | ▲ | ▼ | ▼ | ▼ | — | ▲ | ▲ |
| Any market-rate program | ▲ | ▲ | ▲ | ▲ | ▼ | ▼ | — | ▲ | ▲ | ▼ | — | ▼ | — | ▼ | ▼ | ▲ | ▲ | ▲ | ▲ | ▲ | ▲ | ▼ | ▼ | ▼ | ▲ | ▲ | ▲ |
| Income qualified audit & direct install | ▼ | ▼ | ▲ | ▲ | ▲ | ▲ | ▼ | — | ▲ | ▼ | ▲ | — | ▼ | ▲ | — | — | ▲ | — | — | ▲ | — | ▼ | ▼ | ▲ | ▼ | ▲ | ▲ |
| Audit & direct install | ▲ | — | ▲ | ▲ | ▲ | ▲ | — | — | ▼ | — | — | — | — | ▼ | ▼ | ▲ | ▲ | — | — | ▲ | — | ▼ | ▼ | — | — | ▲ | ▲ |
| HVAC rebate | ▲ | ▲ | ▲ | ▲ | ▼ | ▼ | — | — | ▲ | ▼ | — | ▼ | — | ▼ | ▼ | ▲ | ▲ | — | — | ▲ | ▲ | ▼ | ▼ | ▼ | ▲ | ▲ | ▲ |
| Appliance recycling | ▲ | — | ▲ | ▲ | ▼ | ▼ | ▲ | ▲ | ▲ | ▼ | ▲ | — | — | ▼ | ▼ | ▲ | — | — | — | ▲ | — | ▼ | — | ▼ | — | ▲ | ▲ |
| Literature | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | ▲ 7<br>— 3 | ▲ 2 | ▲ 3 | ▲ 1 | — 2<br>▼ 1 | ▲ 1 | ▲ 1<br>— 2<br>▼ 1 | ▲ 1 | ▲ 2<br>— 2<br>▼ 2 | ▲ 1 | | ▲ 1 | ▲ 1 | | ▲ 1 | — 1<br>▼ 2 | — 1 | ▲ 4 | ▲ 2 | | ▼ 2 | ▼ 1 | ▲ 1<br>▼ 2 | ▲ 1<br>▼ 1 | — 1 | ▲ 1 | ▲ 1 |

# Summary of literature review

| Source | Place | Years covered | HH† income | HoH educa-tion | Black HoH† | Latino White HoH | Other race / ethnicity | Limited English | Energy poverty | HoH age | Owner-ship | Tenure | Number of units | Vintage | Urbani-zation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Survey data (household-level demographics) | | | | | | | | | | | | | | | |
| Burke & Cooper, 2013 | | | | | | | | | | | | | | | |
| market rate | National | 2009-2011 | ▲ | | | | | | | ▼ | ▲ | | | | |
| weatherization | | | — | | | | | | | ▼ | ▲ | | | | |
| Cohn, 2015 | National | 2015 | | | — | ▲ | ▲ | | | | | | | | |
| DNV-GL, 2017 | NY | 2016-2017 | ▲ | ▲ | | | | | | ▼ | ▲ | | | | |
| Frank & Nowak, 2016 | CA | 2010-2012 | ▲ | ▲ | ▼ — | ▼ — | ▼ — | ▲ | | | | | | ▲ ▼ | |
| Illume et al., 2020 | IN | 2019 | ▲ | | | | | | | | | | | | |
| Navigant et al., 2020 * | MA | 2013-2017 | ▲ | ▲ | | | | ▲ | ▲ | | ▲ | ▼ | ▼ ▲ | — | |
| Research Into Action, 2019 | OR | 2018 | — | ▲ | — | — | — | | | — | ▲ | | ▼ | | |
| Wemple et al., 2016 * | | | | | | | | | | | | | | | |
| market rate | National | 2013-2015 | | | ▲ | ▲ | ▲ | | | | | | | | |
| weatherization | | | | | ▲ | ▲ | ▲ | | | | | | | | |
| Utility data (place-based demographics) | | | | | | | | | | | | | | | |
| DNV-GL, 2019 | MA | 2013-2017 | ▲ | | | | | | | | ▲ | | | | |
| Navigant, 2017 * | | | | | | | | | | | | | | | |
| market rate | RI | 2009-2015 | ▲ | | | | | | | — | ▲ | ▼ | ▼ | | ▲ |
| income qualified | | | — | | | | | | | — | — | ▼ | ▼ | | ▲ |
| Rubado et al., 2018 | | | | | | | | | | | | | | | |
| capital investment | OR | 2013-2017 | ▲ | | | | ▲ ▼ | | | | | | | | ▲ |
| free to participant | | | — | | | | ▲ ▼ | | | | | | | | ▲ |